MOLLUSCAN REMAINS FROM ABORGINAL MIDDENS AT THE CLINCH RIVER BREEDER REACTOR PLANT SITE, ROANE COUNTY, TENNESSEE

PAUL W. PARMALEE
FRANK H. McCLUNG MUSEUM
UNIVERSITY OF TENNESSEE
KNOXVILLE, TENNESSEE 37996, U.S.A.
and
ARTHUR E. BOGAN
DEPARTMENT OF MALACOLOGY
THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA, PENNSYLVANIA 19103, U.S.A.

ABSTRACT

Extensive archaeological testing and excavations of multi-component aborginal sites at the proposed Clinch River Breeder Reactor Plant (CRBRP), Roane County, Tennessee were carried out from October 1973 to January 1974 and during December 1974. Approximately 23,900 valves of freshwater mussels representing at least 43 species, and about 5,000 aquatic gastropods representing a minimum of seven species were identified from the recovered shell samples. At least three species of gastropods and 26 species of naiads identified from these aboriginal habitation sites have been extirpated from this now impounded stretch of the Clinch River. Five species of naiads represented in these middens (site 40RE108) are extinct and 14 are classified as Threatened or Endangered. The prehistoric inhabitants who lived along this stretch of the Clinch River from about 800 B.C. to A.D. 1100 heavily exploited the river's molluscan resources. The archaeological samples probably accurately reflect the species composition and their relataive abundance in these early molluscan assemblages.

The rich naiad fauna of the Clinch River has been widely collected and reported. Samuel N. Rhoads, in his contributions to the zoology of Tennessee, documented the diversity of pelecypods in Tennessee and listed Patton's Ferry, Roane County, as one of his collecting locales (Pilsbry and Rhoads, 1897). Ortmann (1918), in discussing the fauna of various collecting locales on the Clinch River, noted that Rhoads collected 16 species of mussels at Patton's Ferry. Ortmann (1918) collected 28 species (including the four closely related species or forms of *Pleurobema*) from the Clinch River at Solway, Knox County, and cites Bryant Walker's collection of four species of naiads from Poplar Creek, a tributary of the Clinch River in Roane County (Ortmann, 1918). Cahn (1936) collected 45 species of naiads immediately below Norris Dam on the Clinch River at the time of the closure of the flood gates. Hickman (1937) surveyed the Clinch River in the vicinity of Norris Dam from 1935 to 1937, recording 39 species of pelecypods. These early records document some of the faunal diversity formerly found at and above the CRBRP site. Stansbery (1973) presented a preliminary report on the naiad fauna of the upper Clinch River, recording a total of 65 species and subspecies. The most recent survey of the Clinch River was undertaken by Ahlstedt (1984). At least 25 of the species in Stansbery's list (1973) are considered as either rare or endangered, while seven are probably now extinct (Stansbery, 1970, 1971; Greenwalt, 1976). Bates and Dennis (1978) provide the most recent data on naiad assemblages found in the unimpounded stretches of the Clinch River in Tennessee and Virginia.

The aquatic gastropod fauna of East Tennessee has also been extensively studied, but publications dealing with species distribution within individual river drainages are lacking except for the early work by Rhoads (Pilsbry and Rhoads, 1897) and intensive studies of *Io* spp. The genus *Io* has been carefully documented as to its clinal variations, habitat and distribution in the upper Tennessee River and its tributaries (Lewis, 1876; Adams, 1900, 1915; Lutz and Weese, 1951). Goodrich (1937; 1938) discussed the pleurocerid fauna of East Tennessee; this report was later supplemented by a reanalysis of species distribution by Sinclair (1969). Sinclair

American Malacological Bulletin, Vol. 4(1) (1986):25-37

(1969) reported that of the seven pleurocerid gastropods formerly inhabiting the main Tennessee River, only *Pleurocera canaliculatum* (Say, 1821) was left, while the others are now found only as relic naiad populations in tributary streams. However, Isom et al. (1979) reported the rediscovery of *Lithasia verrucosa* (Rafinesque, 1820), *Lithasia geniculata salebrosa* (Conrad, 1834) and *Pleurocera alvare* (Conrad, 1834) below Wilson and Wheeler dams in northern Alabama.

Prior to impoundment and channel modification, there was a shoal area, Pickle's Shoals, located below Pickle Island at Clinch River Mile (CRM) 15.5 (24.8 km). This shoal area was recorded as being 1,200 feet (363.6 m) in length with a rock substratum and a minimum low water depth of one foot (0.3 m) (Kingman, 1900). This shoal area corresponds to the location of 40RE108.

The Clinch River Breeder Reactor Plant (CRBRP) was to be the first demonstration plant in the nation's Liquid Metal Fast Breeder Reactor program. The site chosen for its construction is situated on a peninsula formed by a meander of the Clinch River between Clinch River Mile 14.5 (23.2 km) and 18.6 (29.7 km), Roane County, Tennessee (Fig. 1). Although technically within the city limits of Oak Ridge, the site is located in the southwestern section on undeveloped property that is owned by the U.S. Government and in the custody of the Tennessee Valley Authority. Backers of this plant promoted its economic feasibility through the production of cheap and efficient energy by greater use of nuclear fuel in converting Uranium (U-238) to fissionable Plutonium (Pu-239). The 91st Congress approved initial funding of the project in 1972. Following a decade of delays, the project was stopped in 1983 when Congress denied the project further appropriations.

METHODS AND MATERIALS

In compliance with the National Historic Preservation Act of 1966 requiring survey, testing and excavation of archaeological sites in areas to be affected by federally funded construction projects, a survey of the proposed CRBRP site was undertaken and a series of freshwater shell middens was located. The site (40RE108), situated on the right bank of the Clinch River between CRM 15 (24.0 km) and CRM 15.5 (24.8 km), is about 1.5 miles (2.4 km) southeast of Tennessee Highway 58 bridge, Roane County, Tennessee (Fig. 1). Archaeological investigations at the CRBRP site were directed by Dr. Gerald F. Schroedl (1973 a,b,c; 1974; 1975), Department of Anthropology, University of Tennessee, Knoxville; these began in areas designated as I and II (Fig. 2) on 12 October 1973 and were continued until January 1974. Additional testing was carried out in area III during December 1974. Material from the excavations was waterscreened and 40-liter samples of shell were taken from each of the 2 x 2 m excavation units. In units with less than 40 liters, all of the shell was saved (Schroedl, 1973c). Approximately 500 liters of shell were returned to the Department of Anthropology, University of Tennessee, Knoxville, where all samples were carefully washed, identified, and rebagged. Most of the CRBRP shell was deposited in the Section of Zooarchaeology, Department of Anthropology, University of Tennessee; a series of voucher specimens has been placed in the collections of the Department of Malacology, Academy of Natural Sciences, Philadelphia, Pennsylvania.

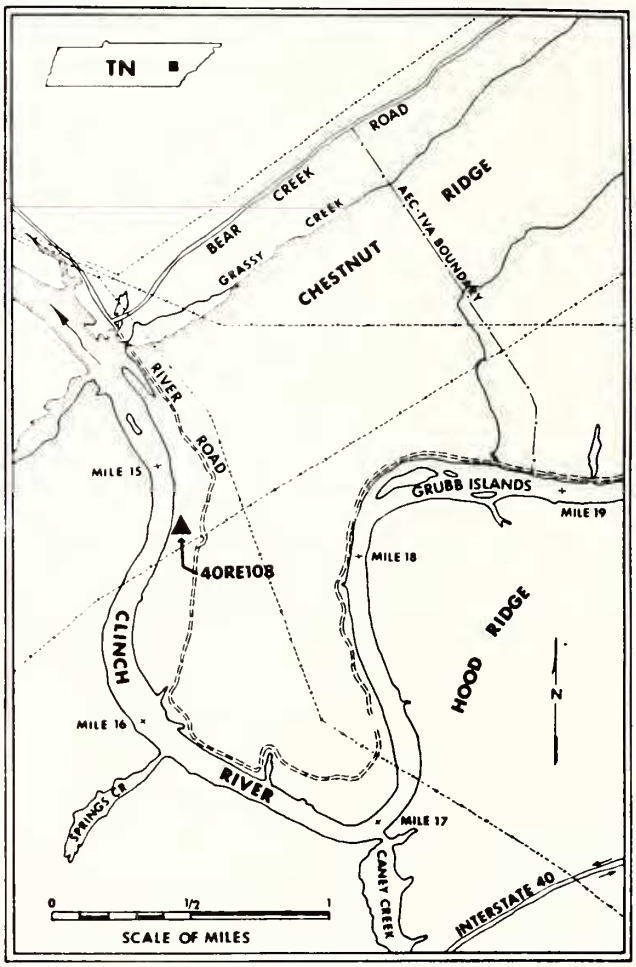

Fig. 1. Map showing location of the CRBRP site.

The site was composed of three separate shell middens that were eroding out of the river bank. Areas I and II were initially recorded by the Watts Bar Reservoir Archaeological Survey in 1941 (Nash, n.d.), while Area III was discovered during river bank reconnaissance at the time of the 1973 testing and excavations (Schroedl, 1973c). Area I was almost completely excavated; two features within this area were completely excavated and all of the recovered molluscan remains were saved. Area II was extensively sampled with about 30 to 50% of the area excavated. The Mississippian shell lense was sampled with again about 30 to 50% of the area excavated. Since these three excavation areas were being eroded by the Clinch River, it was difficult to determine the original extent of the occupation of these areas.

Fig. 2. One of several shell lenses exposed during 1973 excavation at the CRBRP Site.

Excavations in Area I yielded mollusks from the Plow Zone, and Middle and Early Woodland components. Area II contained mollusks in the Plow Zone and in a buried Middle Woodland component. Area III again had mollusks in the Plow Zone and in a buried Mississippian component, but it contained no Woodland materials. Two Early Woodland and three Middle Woodland radiocarbon dates were obtained (Geochron Laboratories Division, Cambridge, Massachusetts). The Early Woodland component dates between 785-345 B.C., while the Middle Woodland component dates between A.D. 65-625. The first and third dates for the Middle Woodland material were considered by Geochron Laboratories as the best of the three (Schroedl, pers. comm.). The Mississippi component is currently undated, but appears to be Early Mississippian, about A.D. 1100 (Schroedl, pers. comm.).

As used in the context of this discussion, Plow Zone refers to the humus and other soil layers disturbed by agricultural activities; Early Woodland and Middle Woodland refer to prehistoric aboriginal groups characterized by small villages or settlements whose subsistence activities depended primarily on hunting and gathering skills; and Mississippian refers to a late prehistoric cultural group who established large permanent villages and who developed agriculture (especially the growing of maize) to the extent that crops played a significant role in their food economy.

The naiads from the excavation units were intially sorted to species and recorded as to right or left valve by straum and area. The total number of valves from the three major cultural components, the Plow Zone, and areas lacking provenience are recorded in Table 1. Gastropods from each excavation unit were identified and tabulated at the same time as the pelecypods and are listed in Table 2; this table summarizes the gastropod fauna by cultrual unit. G.F. Schroedl (pers. comm.) is of the opinion that the two Middle Woodland components were contemporaneous; therefore the shell from these have been combined for comparison with the Early Woodland and Mississippian samples.

RESULTS

ACCOUNTS OF SPECIES: PELECYPODA

Amblema plicata (Say, 1817): The Three-ridge is today one of the more common and widely distributed species throughout the Tennessee River system. Valves of *A. plicata*

Table 1. Freshwater mussels identified from the CRBRP site, all components.

Species	Early Woodland		Middle Woodland		Mississippian		Plow Zone/No Provenience		Total: All Components/Areas	
	No. of Valves	%	No. of Valves	%	No. of Valves	%	No. of Valves	%	No. of Valves	%
Amblema plicata	2	2.15	375	1.85	128	4.72	18	2.09	523	2.19
Fusconaia barnesiana	2	2.15	64	.31	13	.48	1	.11	80	.33
Fusconaia subrotunda	1	1.07	1,528	7.55	155	5.71	62	7.20	1,746	7.30
Quadrula cylindrica	—	—	62	.30	38	1.40	3	.35	103	.43
Quadrula intermedia	2	2.15	261	1.29	38	1.40	2	.23	303	1.27
Quadrula metanevra	—	—	—	—	2	.07	—	—	2	.01
Quadrula pustulosa	—	—	17	.08	29	1.07	2	.23	48	.20
Quadrula sparsa	—	—	89	.44	18	.66	6	.69	113	.47
Cyclonaias tuberculata	9	9.67	1,700	8.40	278	10.24	55	6.39	2,042	8.54
Elliptio crassidens	—	—	18	.09	—	—	—	—	18	.07
Elliptio dilata	10	10.75	1,233	6.09	115	4.24	70	8.13	1,428	5.97
Lexingtonia dolabelloides	—	—	314	1.55	91	3.35	33	3.83	438	1.83
Plethobasus cicatricosus	—	—	1	T	—	—	—	—	1	T
Plethobasus cooperianus	—	—	8	.04	15	.55	1	.11	24	.10
Plethobasus cyphyus	—	—	3	.01	—	—	—	—	3	.01
Pleurobema clava	—	—	94	.46	26	.96	7	.81	127	.53
Pleurobema cordatum	—	—	12	.06	5	.18	—	—	17	.07
Pleurobema plenum	5	5.37	3,063	15.13	288	10.61	110	12.77	3,466	14.50
Pleurobema pyramidatum	3	3.22	517	2.55	95	3.50	19	2.20	634	2.65
Pleurobema spp.	4	4.30	818	4.04	176	6.48	51	5.92	1,049	4.39
Actinonaias ligamentina	20	21.50	2,822	13.94	268	9.88	118	13.70	3,228	13.50
Epioblasma arcaeformis	1	1.07	789	3.90	155	5.71	24	2.79	969	4.05
Epioblasma brevidens	4	4.30	995	4.91	48	1.77	41	4.76	1,088	4.55
Epioblasma capsaeformis	2	2.15	52	.25	24	.88	6	.69	84	.35
Epioblasma cf. *florentina*	—	—	—	—	15	.55	—	—	15	.06
Epioblasma haysiana	—	—	359	1.77	64	2.36	16	1.86	439	1.83
Epioblasma cf. *obliquata*	—	—	3	.01	—	—	—	—	3	.01
Epioblasma propinqua	1	1.07	119	.59	107	1.94	9	1.04	236	.98
Epioblasma stewardsoni	—	—	178	.88	9	.33	11	1.28	198	.83
Epioblasma torulosa	1	1.07	254	1.25	51	1.88	10	1.16	316	1.32
Epioblasma triquetra	1	1.07	20	.10	9	.33	—	—	30	.12
Lemiox rimosus	1	1.07	503	2.48	96	3.54	23	2.67	623	2.60
Lampsilis cf. *orbiculata*	—	—	1	T	—	—	—	—	1	T
Lampsilis fasciola	—	—	13	.06	5	.18	3	.35	21	.09
Lampsilis ovata	—	—	33	.16	3	.11	2	.23	38	.16
Ligumia recta	—	—	5	.02	—	—	—	—	5	.02
Obovaria cf. *subrotunda*	—	—	12	.06	3	.11	5	.58	20	.08
Villosa cf. *taeniata*	—	—	2	.01	2	.07	—	—	4	.01
Villosa trabalis	—	—	1	T	—	—	—	—	1	T
Villosa vanuxemensis	—	—	21	.10	7	.26	—	—	28	.12
Villosa sp.	—	—	4	.02	2	.07	—	—	6	.02
Cyprogenia stegaria	17	18.28	2,166	10.70	186	6.85	94	10.92	2,463	10.30
Dromus dromas	4	4.30	862	4.26	77	2.84	31	3.60	974	4.07
Ptychobranchus fasciolare	2	2.15	732	3.61	34	1.25	23	2.67	791	3.31
Ptychobranchus subtentum	1	1.07	115	.57	38	1.40	5	.58	159	.66
TOTALS	93	99.93	20,238	99.89	2,713	99.93	861	99.94	23,905	99.90

totaled 523 for all CRBRP site samples, varying between 2% and 5% for each of the three cultural components. It was present from Early Woodland through the Mississippian period, but it may not have been as numerous in prehistoric times as it is at present.

Fusconaia barnesiana (Lea, 1838): Only 80 valves of this species were identified from the sample, but this small number is not unexpected as this species tends to inhabit primarily medium-to-small rivers and headwater streams.

Fusconaia subrotunda (Lea, 1831): Nearly 1,750 valves of this species, representing slightly over 7% of all identified shells, were recovered and attest to its former

Table 2. Summary of freshwater gastropods from all components, 40RE108

Gastropoda	Early Woodland		Middle Woodland		Mississippian		Plowzone		Total	
	Total	%	Total	%	Total	%	Total	%	Total	%
Campeloma sp.	10	1.17	17	.61	5	.42	4	1.96	36	.72
cf. Elimia sp.	—	—	1	.03	—	—	6	2.94	7	.14
Io fluvialis	11	1.29	582	21.05	18	1.51	21	10.29	632	12.61
Leptoxis crassa	228	36.79	19	.69	451	37.83	17	8.33	715	14.27
Leptoxis cf. praerosa	65	7.64	7	.25	5	.42	—	—	77	1.53
Lithasia verrucosa	67	7.87	7	.25	15	1.25	—	—	89	1.77
Pleurocera canaliculatum	356	41.83	2118	76.63	698	58.55	150	73.53	3322	66.29
Unidentifiable	114	13.39	13	.47	—	—	6	2.94	133	2.65
TOTAL	851	99.98	2764	99.98	1192	99.98	204	99.99	5011	99.98

abundance in the lower Clinch River. *Fusconaia subrotunda* occurs throughout the Ohio, Cumberland, and Tennessee River systems and may be found inhabiting the deeper portions of large rivers as well as small streams and the more shallow upstream sections of rivers such as the upper Clinch and Powell. Specimens from the CRBRP samples were generally thick-shelled and inflated, thus suggesting a former habitat consisting of fairly deep water and strong current (for further information see Ortmann, 1920).

Quadrula cylindrica (Say, 1817): All of the approximately 100 valves of the Rabbit's Foot were from small (young ?) individuals; although none were complete enough for anterior-posterior length measurements, visual estimates of the fragmentary valves suggest few if any exceeded 65 mm in total length. *Quadrula cylindrica* appears to attain its greatest size in medium-to-small size streams such as French Creek, Pennsylvania and the upper Powell and Clinch rivers in extreme northeast Tennessee. The probable fast water/shoal habitat adjacent to the site area may not have been favorable for individual maximum growth and population abundance in the case of several species represented at 40RE108, those generally adapted to a smaller river or stream environment.

Quadrula intermedia (Conrad, 1836): This species was once found throughout most of the Tennessee River system above Muscle Shoals, Alabama, but due to impoundments and other detrimental factors the upper Powell and Clinch rivers contain what appears to be the last viable populations. A few (relic ?) individuals are still known to be living in the Duck River, Maury County, Tennessee (S. A. Ahlstedt, pers. comm.). Although apparently not numerous in the lower Clinch River, *Q. intermedia* appears to have been well established; like *Q. cylindrica*, all valves of this species were small and compressed with none having developed the thick shell or large size of those now inhabiting the upper Powell River.

Quadrula metanevra (Rafinesque, 1820): The *Quadrula metanevra-Quadrula sparsa* complex poses a taxonomic problem that is not easily resolved. Superficially *Q. sparsa* resembles *Q. metanevra* in general shape of the shell, but is more compressed and lacks the large, distinct, protruding tubercles forming the high posterior ridge characteristic of typical *Q. metanevra*. The majority of CRBRP site specimens exhibit a more uniform distribution and size of tubercles over the posterior two-thirds of the valve; some possess a distinct sulcus that is nearly or completely void of tubercles (as in typical *Q. sparsa*) while others lack the sulcus and distinct posterior ridge and show a more uniform distribution of tubercles (Fig. 3). These specimens appear to be a down river form of *Q. sparsa*, yet in some specimens characters appear similar to those defined by Morrison (1942) for a new species, *Quadrula biangulata* (Morrison, 1942), he described from the Pickwick Basin mounds. Whatever the identity of the organism, it was not overly abundant (113 valves) in the sample and comprised only 0.5% of all naiads recovered. Only one small individual (paired valves) of typical *Q. metanevra*, a species previously unreported from the Clinch River, was encountered in the CRBRP site naiad sample (Mississippian component).

Quadrula pustulosa (Lea, 1831): Today the Pimpleback is one of the most widely distributed and common species of mussels found in Tennessee, occurring in small streams as well as in large rivers. Apparently it was not a common shell in the Tennessee River system in aboriginal times. Only 48 valves of *Q. pustulosa* (0.20% of total) were identified from the CRBRP site sample; it was also rare or absent in shell midden samples examined from several other sites along the Tennessee River in Rhea and Meigs counties (Parmalee et al., 1982).

Cyclonaias tuberculata (Rafinesque, 1820): Shells of the Purple Warty-back were second in number (2,042) only to those of *Actinonaias ligamentina* (Lamarck, 1819). Morrison (1942:357) reported *C. tuberculata* as being ". . . extremely abundant in all the mounds" in the Pickwick Basin shell mound samples, while it was less than abundant but still common in the naiad material analyzed from the Widows Creek Site (Tennessee River) in northeast Alabama (Warren 1975). Although this species has been greatly reduced in numbers or completely eliminated in impounded areas, it still occurs commonly in numerous streams and rivers such as the upper Clinch and Powell. It was apparently common in the shoals area adjacent to the CRBRP site and the Indian made good use of this mussel; all age sizes were represented in the

samples, from juveniles the size of a quarter to extremely large, old individuals. Valves of *C. tuberculata* varied from about 8% in the Middle Woodland component to 10% in the Mississippian.

Elliptio crassidens (Lamarck, 1819): Considering the present abundance of the Elephant Ear in the Tennessee River and its major tributaries, even in stretches affected by impoundment, it is surprising that only 18 valves were recovered. Morrison (1942) reported only a few individuals from the Pickwick Basin mounds and attributed its rarity to the fact that it inhabits water too deep for wading. Although this is generally true, it almost certainly could have been taken in considerable numbers—if present—during periods of low water.

Elliptio dilatata (Rafinesque, 1820): The Spike is one of the most common mussels found throughout the Tennessee River system, occurring in headwater streams as well as in the large, deep water rivers. The 1,428 valves of *E. dilatata* comprised 6% of all identified naiad remains recovered at the CRBRP site. Although numerous shells of small juveniles were recovered, thick heavy valves of old adults—indicative of a large river/fast current habitat—were also common.

Lexingtonia dolabelloides (Lea, 1840): A total of 438 valves, which comprised 2% of all mussel shells recovered, were determined to be this species. The shell of *L. dolabelloides* exhibits considerable variation in size, shape, and degree of inflation and certain individuals superficially resemble forms of *Pleurobema* to which *L. dolabelloides* is closely related. Weathered specimens from an archaeological context compound the problem. Many of the "less-than-typical" valves of the *Pleurobema/Lexingtonia* complex from the CRBRP site were difficult to identify with complete certainty. *L. dolabelloides* seems to reach its greatest abundance in medium-sized rivers (e.g. the Duck River in Middle Tennessee), although former shoals of the Tennessee River apparently supported large populations.

Plethobasus cooperianus (Lea, 1834): Today the Orange-footed Pimple-back is rare and may be on the verge of extinction. In Tennessee it formerly inhabited the larger rivers such as the Tennessee, French Broad and Holston; Ortmann (1918) reported it as also occurring in the lower Clinch. There are apparently no records of its former abundance but, judging by the paucity of specimens (about 17 individuals) from the CRBRP site samples, it was not common in the lower Clinch River during aboriginal times. In archaeological context shells of *P. cooperianus* might be confused with those of *Cyclonaias tuberculata*; fresh specimens differ from the latter species in having white rather than purple nacre and a much shallower beak cavity. *Plethobasus cooperianus* is *Plethobasus striatus* (Rafinesque, 1820) as used by Bogan and Parmalee (1983). The type of *P. striatus* as preserved in the Academy of Natural Sciences, Philadelphia, Malacology Collections, is *Obovaria subrotunda* (Rafinesque, 1820), while the type in the Museum National d'Histoire Naturelle, Paris, France is *Cyprogenia stegaria*. Thus, we consider *P. cooperianus* the valid name for the species.

Plethobasus cyphyus (Rafinesque, 1820): The Sheepnose was poorly represented in the CRBRP site samples (3 specimens), although it is a common shell in the upper Clinch and Powell rivers today. The typical form of *Plethobasus cyphyus* was apparently extremely rare in the lower Clinch in prehistoric times.

Plethobasus cicatricosus (Say, 1829): Some authors (e.g. Burch, 1975) consider this species synonymous with *P. cyphyus*, but one specimen recovered from the CRBRP site Middle Woodland component and the numerous valves encountered in Woodland and Dallas (Mississippian) shell middens along the Tennessee River in Meigs and Rhea counties (Parmalee *et al.*, 1982) are quite distinct from the modern shell form of *P. cyphyus*. Valves of *Plethobasus* from these latter sites are oblong, compressed and thick, the beaks project forward and there is a row of low, dense tubercles runnig from the beak to the center of the ventral margin. Whatever form or species these valves represent, it was apparently rare in the lower Clinch.

Pleurobema clava (Lamarck, 1819): In the Interior Basin drainage, *P. clava* occurs in the Ohio, Cumberland, and Tennessee River systems. Valves assigned to this species from the CRBRP site were typical of medium-to-large river forms in that the anterior portion of the shell was thick and swollen and the beaks were more anteriorly positioned. Another species, *Pleurobema oviforme* (Conrad, 1834), is closely related to and possibly a southern counterpart of *P. clava* which occurs most often in small-to-medium sized rivers. However, no valves could be assigned to *P. oviforme* and it is felt that identification of the 127 specimens as *P. clava* is correct.

Pleurobema cordatum Rafinesque, 1820 (= ?*Pleurobema obliquum* [Lamarck, 1819]), *Pleurobema coccineum* (Conrad, 1836), *Pleurobema plenum* (Lea, 1840), and *Pleurobema rubrum* (Rafinesque, 1820) (= *P. pyramidatum*): The taxonomic problems involving the correct assignment of *P. plenum, P. rubrum* and *P. coccineum* to subspecific or species rank has already been considered. Athough *P. coccineum* occasionally is found inhabiting large rivers, it apparently attains maximum abundance in smaller streams and headwaters; no valves of the *Pleurobema* spp. group from the CRBRP site could positively be assigned to this form. Neel and Allen (1964) comment that *Pleurobema cordatum pyramidatum* ". . . occurred only on the big [Cumberland] river bars," and that *Pleurobema cordatum plenum* ". . . was found in goodly numbers on all main stem bars," and that these variants or subspecies ". . .often occur side by side with the parent form [*P. cordatum*] . . . seemingly have the same habitat preferences as the parent form." Judging from the various forms of *Pleurobema* represented in the CRBRP site material, the same situation must have formerly prevailed in the lower Clinch River in the vicinity of this site.

Shells of the parent form were few in number; however, considering all valves of the *Pleurobema cordatum* complex together, they totaled 5,166 which constituted nearly 22% of the entire sample. Valves of *P. plenum* alone comprised almost 15% of the total sample. The shoals and gravel bars

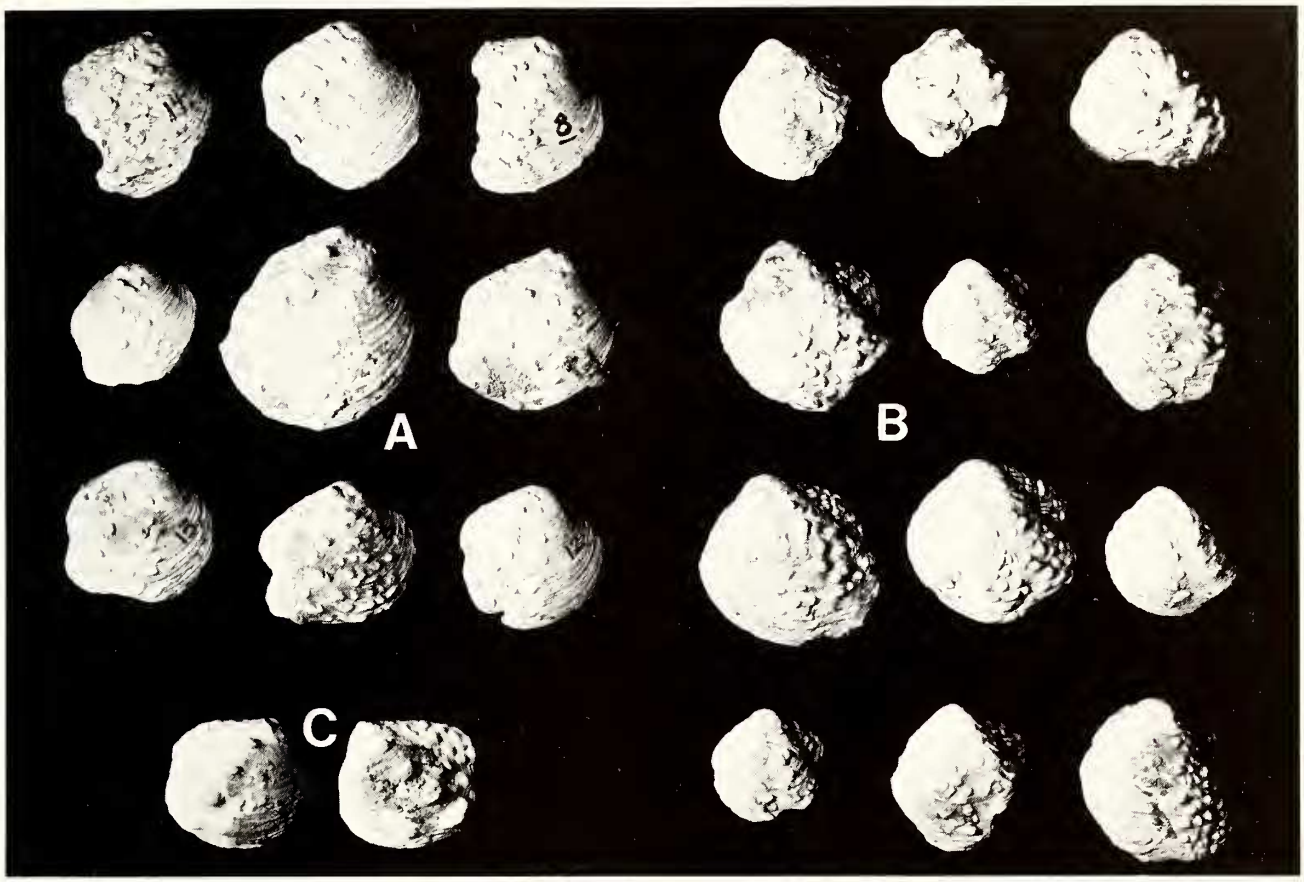

Fig. 3. Examples of right (A.) and left (B.) valves of *Quadrula sparsa* from the CRBRP Site illustrating variation in pustule arrangement. The specimens of *Quadrula metanevra* (C.) encountered in the CRBRP site molluscan sample.

adjacent to the site must have supported a rich and varied naiad fauna with individuals of the *Pleurobema* group and those of the following species comprising about one third of the population.

Actinonaias ligamentina (Lamarck, 1819): Slightly over 3,200 shells of the common Mucket were identified, the largest number for any single species recorded from the CRBRP site. Nearly 1,700 individuals were represented and their shells comprised 13.5% of all valves recovered. Today the Mucket is still one of the most common naiads in the unimpounded Clinch River above the Norris Reservoir. During the various periods this site was occupied, *A. ligamentina* must also have occurred abundantly in the shoal areas of the lower Clinch River. Because of the close similiarity in shell characters between this species and the Pink Mucket (*Lampsilis orbiculata* (Hildreth, 1828)), especially in the males, a few of the valves recorded as *A. ligamentina* may be those of the Pink Mucket.

Epioblasma arcaeformis (Lea, 1831): The Sugar Spoon was once widespread throughout the Tennessee and Cumberland River systems, but it has not been collected in over 50 years and is presumed extinct (Stansbery, 1970). In addition to inhabiting small tributary streams, it occurred on shoals of the larger rivers such as the Tennessee and lower Clinch. Over 900 valves of *E. arcaeformis* were recovered in the CRBRP site samples with both juveniles and old adults being represented. All species of *Epioblasma* identified from the site are relatively small mussels. However, as in the case of nearly all species represented in the samples, small juveniles as well as large adults were collected, so it would appear that the Indian was not selective as to the size of individuals (or species) utilized.

Epioblasma brevidens (Lea, 1831): Of the 10 species and/or forms of *Epioblasma* represented in the CRBRP site samples, valves of *E. brevidens* were the most numerous (1,088). This mussel is still common locally in the upper Clinch and Powell rivers but, like many of the smaller species formerly found in shoal and bar areas of big rivers, it has disappeared in the impounded stretches. Shells of all species of *Epioblasma* identified from the site numbered nearly 3,400 and comprised 14% of the total.

Epioblasma capsaeformis (Lea, 1834): Ortmann (1925) stated that this species is ". . . apparently as abundant in the lower Tennessee drainage as in the upper, both in larger and smaller streams." It apparently was not numerous in the shoal area adjacent to the site as only 84 valves were recovered. Identification of several of these closely related

forms is difficult, and often impossible, when the valves are chalky and incomplete. This species and *Epioblasma florentina* (Lea, 1857) are very similar, and the problem of distinguishing between the two from archaeological specimens usually cannot be done with absolute certainty. Only 15 shells of *E.* cf. *florentina* were identified from the sample.

Epioblasma haysiana (Lea, 1833): Once found widely distributed throughout the upper Tennessee and Cumberland River drainages in both large rivers and small tributary streams, *E. haysiana*, the Acorn, was reduced to a single population in a 10 mile (16.0 km) stretch of the upper Clinch River in Virginia (Stansbery 1970). In all probability it is now extinct, judging by the present poor condition of that section of the river and the failure to find a single shell during recent collecting trips. A total of 439 valves were recovered, suggesting that it was probably only moderately common in the lower Clinch River in prehistoric times.

Epioblasma stewardsoni (Lea, 1852): Differences between archaeological specimens of this species, *Epioblasma lewisi* (Walker, 1910) and *Epioblasma flexuosa* (Rafinesque, 1820) are often subtle; added to the problem of incomplete preservation are the normal variations between and among species due to age and sex. Therefore, it is possible that a few of the 198 specimens recorded in Table 1 as *E. stewardsoni* are *E. lewisi* and/or *E. flexuosa* but, for the most part, all compared closely with *E. stewardsoni*. All three species are now extinct; *E. stewardsoni* inhabited the Tennessee River and apparently the lower stretches of its major tributaries, while *E. lewisi* (a small river form of *E. flexuosa*?: Johnson, 1978) occurred in the upper Tennessee, Clinch and Holston rivers.

Epioblasma* cf. *obliquata (Rafinesque, 1820) [= *Epioblasma sulcata* (Lea, 1824)]: This is an Ohio River drainage species with the form *Epioblasma obliquata sulcata* occurring in the Green River, Kentucky and in the Cumberland River, Kentucky/Tennessee. Although the three specimens from the Middle Woodland component compared closely with fresh material of *E. obliquata*, our determinations are only tentative in light of the past distribution of this species and the fact that these mature specimens may represent males of *Epioblasma propinqua* (Lea, 1857).

Epioblasma torulosa (Rafinesque, 1820), ***Epioblasma propinqua*** (Lea, 1857): Two distinct forms (or species if *propinqua* should be treated as such) of the *E. torulosa* complex were apparent in the CRBRP site material. The species *Epioblasma torulosa gubernaculum* (Reeve, 1865) appears to inhabit medium-sized rivers while *E. propinqua*, which has not been collected in over 50 years and is presumed extinct, reached its greatest population density in the Tennessee River and the lower reaches of its major tributaries. Although the majority of shells of *E. torulosa* from the CRBRP site could be separated into either *E. t. gubernaculum* (valves compressed, tuberculate) or *E. propinqua* (valves inflated, heavy, and lacking tubercules), a few appeared to be intergrades between the two. Regardless, both species occurred in the shoals and riffles adjacent to the site; combined, valves of *E. torulosa* and *E. propinqua* totaled 552 which comprised slightly over 2% of the total.

Epioblasma triquetra (Rafinesque, 1820): Although the Snuffbox is an inhabitant of both large and small rivers, it tends to be most numerous in the small-to-medium sized rivers. It is, for example, a common shell in the upper Clinch and Powell rivers; judging by the paucity of valves (30) from the CRBRP site samples, it must have been uncommon to rare in that stretch of the lower Clinch.

Lemiox rimosus (Rafinesque, 1820) [= *Conradilla caelata* (Conrad, 1834)]: This small species was once widespread in the Tennessee River system, but populations now appear localized in a few rivers such as the Duck and the upper Clinch and Powell. Ortmann (1918) reported it from the lower Clinch River but commented that, although of wide distribution, it was found nowhere in great numbers. Over 600 valves of *L. rimosus* were identified, suggesting that it may have been a moderately abundant shell at the site location. Living specimens are not easy to find because of their habit of remaining nearly or completely buried in the substrate.

Lampsilis ovata (Say, 1817): The Pocketbook is one of the most widespread and locally common mussels occurring throughout the unimpounded river systems in Tennessee. It is a large species and the valves vary in thickness from moderately heavy to extremely thick. Since most of the specimens identified from the CRBRP site samples consisted of only the umbo/tooth/hinge line, it is possible that preservation, or the lack of it, was a factor in the paucity of valves (38) recovered. However, had *L. ovata* been a common species in the lower Clinch at the CRBRP site, it probably would have been collected by the Indian as one of the more desirable large forms and it would, therefore, have been better represented in the samples.

Lampsilis fasciola (Rafinesque, 1820): Ortmann (1925) stated this species is ". . . of very general distribution in the Ohio drainage, in the Cumberland, lower and upper Tennessee systems, but somewhat scarce in larger rivers, more abundant in smaller ones." Only 21 valves of *L. fasciola* were recovered, so it is apparently true that this species was also rare in the large rivers, at least the lower Clinch, in prehistoric times.

Lampsilis orbiculata (Hildreth, 1828): This large river species of *Lampsilis* has a wide distribution in the major river systems of the Interior Basin, including the Tennessee and Cumberland. Except for the impounded stretches of the middle Cumberland River where it has been taken in considerable numbers by commercial shellers (Parmalee et al., 1980), the Pink Mucket is an uncommon shell throughout most of its range. Only one valve (female) from the site was determined with a degree of certainty as being *L. orbiculata.*

Ligumia recta (Lamarck, 1819): The Black Sandshell is another widely distributed species throughout the major river drainages of the Interior Basin, inhabiting both large and small rivers. It is not a rare species, but it never reaches a population density comparable to that of *Actinonaias ligamentina,* even under ideal habitat conditions. It must have been a rare shell in the lower Clinch at the CRBRP site as only five valves of *L. recta* were encountered in the samples.

Obovaria subrotunda (Rafinesque, 1820): Although this widespread species inhabits both large and small rivers,

remaining Tennessee populations occur in medium-to-small sized rivers such as the Duck and Red. It was perhaps never common in the lower Clinch River; only 20 specimens were encountered in the samples.

Villosa taeniata (Conrad, 1834): This is a species usually restricted to medium-sized to small rivers (e.g. tributaries of the Stones River; Red River; upper Powell River), so the recovery of only four valves tentatively identified as *V. taeniata* from the CRBRP site is not surprising.

Villosa vanuxemensis (Lea, 1838): *V. vanuxemensis* is a locally common member of the naiad fauna of the upper Cumberland and Tennessee River drainages and it is usually found inhabiting only the medium-sized rivers and smaller tributary stream. ***Villosa trabilis*** (Conrad, 1834), of which only one valve was recovered at the CRBRP site, occupies a similar aquatic habitat. Species belonging to this genus are not surprisingly poorly represented in these middens from the lower Clinch River.

Cyprogenia stegaria (Rafinesque, 1820) [= *Cyprogenia irrorata* (Lea, 1830)]: The Fan Shell was once widely distributed and common in the Ohio, Cumberland, and Tennessee River systems, but its former range and populations have been greatly reduced. The last remaining viable population in Tennessee today appears to be restricted to the upper Clinch River. Nearly 2,500 shells of *C. stegaria* (about 10% of the total) occurred in the CRBRP site samples, attesting to its former abundance in the shoal areas of the lower Clinch. Morrison (1942) found it moderately abundant in all of the Pickwick Basin mounds.

Dromus dromas (Lea, 1834): Like *C. stegaria, D. dromas* was an abundant shell throughout the Tennessee and Cumberland River systems but it, too, has been eliminated from most of its former habitat. Its prehistoric abundance in the Tennessee River is exemplified by the approximately 14,100 valves (22% of individuals) recovered at the Widows Creek site (Warren, 1975) and by about 9,800 valves (45% of all naiad shells) reported from 14 Woodland and Mississippian middens in the Chickamauga Reservoir, Tennessee River (Parmalee et al., 1982). Morrison (1942), in commenting on the Pickwick Basin mound material, stated that it was "One of the most abundant species in these shell deposits. According to the number of specimens handled in the course of this study, *dromas* must have been very abundant here previously. These specimens are of good size for the species, and made up a major part of the total mussel fauna gathered for food." Similarly, *D. dromas* must have been a comon species in the lower Clinch River, although perhaps not as abundant as it was in the Tennessee. Nevertheless, nearly 1,000 valves, about 4% of the total, were recovered in the CRBRP site middens; this mussel, because of its large size and abundance, was probably one of the more important food species.

Ptychobranchus fasciolare (Rafinesque, 1820): Valves of the Kidney-shell totaled nearly 800, representing about 3% of all identified naiads. Ortmann (1918) commented that it is ". . . widely and uniformly distributed over the upper Tennessee region, but nowhere in great numbers." It was apparently moderately common in the shoals and gravel bars adjacent to the site, but has now disappeared from the lower Clinch, like most species adapted to such a habitat, due probably to river impoundment.

Ptychobranchus subtentum (Say, 1825): An inhabitant of the upper Tennessee and Cumberland River systems, *P. subtentum* is ". . . more abundant toward the headwaters, and rather rare in the big rivers" (Ortmann, 1918). A total of 159 valves of this species was identified from the CRBRP site samples, thus establishing the former presence of a population at this point in the lower Clinch but one that was probably not extensive.

GASTROPODA

The excavations in Areas I, II, and III yielded 5,011 shells of freshwater gastropods, representing seven species, which were found mixed with the valves of pelecypods (Table 2). The following discussion provides an evaluation of the probable taxonomic position of the gastropods from the CRBRP site, former habitat requirements, and their importance in the subsistence of the inhabitants.

Campeloma indeterminate species: This group was left at the generic level due to the present confusion existing over the synonymy of the multitude of named species and forms. Rhoads collected *Campeloma ponderosum* (Cooper, 1834) from the Clinch River below Patton's Ferry, Roane County (Pilsbry and Rhoads, 1897). Hickman (1937) lists only one species of *Campeloma* from the Clinch River, *Campeloma rufum* (Haldeman, 1841), which was found in abundance in the vicinity of Norris Dam. Bickle (1968) lists four species of *Campeloma* as occurring in Tennessee: *Campeloma crassula* (Rafinesque, 1819), *Campeloma decisum* (Say, 1816), *Campeloma exile* (Anthony, 1860), and *Campeloma geniculum* (Conrad, 1834). Clench (1962) lists *C. ponderosum* as a synonym of *C. crassula, C. rufum* is apparently synonomous with *C. geniculum*, and Baker (1902) and Binney (1865) saw *C. geniculum* as a synonym of *C. decisum*. Burch (1982) lists *C. crassula* and *C. decisum* from Tennessee. In consideration of these views, the archaeological specimens of *Campeloma* might be referred to *C. crassula*, based on the collection records of Rhoads (Pilsbry and Rhoads, 1897) or *C. decisum* based on Hickman's collecting of *C. rufum* in the lower stretches of the Clinch River (Hickman, 1937). Morrison (1942) noted that *Campeloma* spp. would have been available to the prehistoric Indians in quantity since it occurs in shallow areas close to shore.

Elimia sp: Only seven gastropods were encountered that could be referred to this genus; the species was not determined.

Io fluvialis (Say, 1825): This gastropod was formerly widespread in the Tennessee River and its tributaries in East Tennessee (Adams, 1900, 1915), but it is now restricted to the upper Clinch, Powell and Nolichucky rivers above impoundment. Adams (1915) noted that the specimens of *Io fluvialis* he collected from the lower Clinch River were very spinose, but did not assign a subspecies or form name to the specimens. The archaeological specimens from the CRBRP site ranged from about 2 cm in length to very large,

slender, spinose individuals measuring 6.5 cm in length. *Io fluvialis* is typically found in riffle areas with good current and often occurs in association with *Leptoxis* spp., *Lithasia* spp., and *Pleurocera* spp. (Lewis, 1876; Adams, 1915; Hickman, 1937).

Leptoxis (Athearnia) crassa (Haldeman, 1841): Bogan and Parmalee (1983) and Burch (1982) provided the taxonomic history of this species. We will use Burch's generic placement based on radular characters. Hickman (1937) reported *Leptoxis crassa anthonyi* (Redfield, 1854) (= *Eurycaelon anthonyi*) and *Lithasia geniculata* (Haldeman, 1840) from the Clinch River below Norris Dam. However, her figures of *L. geniculata* appear to show *L. crassa* and the figure of *L. c. anthonyi* appears to be *Leptoxis praerosa* (Say, 1824). She reported that *anthonyi* was found on rocks in knee deep water with *Leptoxis* (= *Anculosa*) and *Io (Hickman, 1937). This species was common in the CRBRP archaeological samples (Table 2).*

Leptoxis* cf. *praerosa: Most of the 77 specimens of *Leptoxis* compared well with *L. praerosa*; however, a few of the smaller specimens appear intermediate between *L. praerosa* and *Leptoxis subglobosa* (Say, 1825) (See Walker, 1908).

Lithasia verrucosa (Rafinesque, 1820): The majority of these specimens occurred in the Early Woodland component. Morris (1939) notes that *L. verrucosa* is generally found in bends of sluggish streams, half buried in mud and decaying vegetation. They have been collected by the authors on rocks in shallow water with little current immediately adjacent to the river's edge in the Nolichucky River, East Tennessee.

Pleurocera canaliculatum: Goodrich (1937) collected *Pleurocera canaliculatum undulatum* (Say, 1829) from the Clinch River in Roane and Anderson counties. However, no attempt was made to identify the forms represented at the CRBRP site. This was the most common gastropod identified in the pelecypod sample (3,322 individuals). Goodrich (1938) lists the habitat of *P. canaliculatum* as generally muddy situations; Morris (1939) commented that this species is often found on the open unvegetated shore in moderately shallow water, sometimes buried in the mud with only the spire protruding. *Pleurocera* would have been locally available along with *Campeloma* and *Lithasia*.

These gastropods were all common prior to impoundment and modification of the rivers. *Io fluvialis, Leptoxis praerosa,* and *Lithasia verrucosa* are living only as isolated, relic populations and have been listed as Rare and Endangered (Sinclair, 1969; Stansbery, 1970, 1971; Stein, 1976). Sinclair (1969) found that of the formerly diverse gastropod fauna of the Tennessee River, only *Pleurocera canaliculatum* remained in sizable numbers. The current population status of *Campeloma* spp. is unknown, but it is not endangered due to its generalized habitat requirements and wide distribution.

Cf. ***Busycon*** sp.: One fragment of the body whorl of a marine conch was recovered in Feature 7, a Middle Woodland feature in Area I. This marine shell would have been transported to Tennessee from either the Gulf of Mexico or the southeastern Atlantic Coast. Drilled marine conch columella were found in a Hamilton Late Woodland burial mound (40RE124) adjacent to 40RE108 (Cole, 1975). Marine shells were also recovered in two Early Woodland sites in East Tennessee, the Camp Creek and the Rankin sites (Lewis and Kneberg, 1957; Smith and Hodges, 1968).

DISCUSSION AND CONCLUSIONS

Problems involving the taxonomy of freshwater bivalves have been prevalent for the past century and many have yet to be resolved. Since most genera and species descriptions are based on soft parts, the zooarchaeologist is at a disadvantage in making specific determinations because only isolated valves from the archaeological context are available. Often these shells are chalky and incomplete and any diagnostic color or pattern in the periostracum fades or is obliterated after the specimen has been buried for some time. It is true that the shell structure of many species such as *Amblema plicata* (Say, 1817), *Cyclonaias tuberculata* (Rafinesque, 1820), *Quadrula cylindrica* (Say, 1817), *Lemiox rimosus* (Rafinesque, 1820), and *Cyprogenia stegaria* (Rafinesque, 1820) consists of diagnostic ridges, plications, tubercles and the like which are generally easily recognizable regardless of the loss of color or pattern. It is also true that the often subtle differences in shell color, design pattern and/or structure of fresh specimens used to distinguish or separate certain other closely related species have limited value when it comes to identifying archaeological specimens.

Another problem that must be considered in certain instances when attempting to arrive at specific identifications is that of determining whether or not the specimen or specimens are actually "good species" or instead subspecies, ecological forms, or variants that reflect former habitat conditions. To illustrate, some researchers recognize three distinct large river species, *Pleurobema plenum, Pleurobema coccineum*, and *Pleurobema rubrum,* that are considered by others to be subspecies or forms of *Pleurobema cordatum*. Neel and Allen (1964) provide informative comments on this complex from the Cumberland River Basin; they treated their specimens of *Pleurobema* as subspecies, but commented that "The trinomial system is a convenience, and this complex has long been a part of our mussel lore, but no claims are made for the validity of the subspecific rank." This problem was inherent in several species or forms represented in the CRBRP site samples (e.g. the *Pleurobema cordatum* complex and certain closely related species of *Quadrula, Epioblasma*, and *Villosa*).

The vast quantities of pelecypods that comprise the major portion of the faunal debris of "shell mounds" and midden deposits along the large rivers in the Midwest and Middle South have long been of special interest to both the archaeologist and zoologist. Because these huge concentrations often consist almost entirely of shells, especially sites of primarily Archaic and/or Woodland components, it was generally held that mollusks must have provided the basic meat resource in the subsistence of these early prehistoric peoples. However, at least one study (Parmalee and Klippel,

1974) has shown that the nutritional value of the freshwater mussel is minimal and that, in light of all potential food resources available to the Indian, mollusks provided only a supplemental food source in the diet. Bennett (1955) provides an interesting quote from a 1634 narratiave by Wood on the apparent disdain for mollusks by Indians of southeastern New England:

> "They keepe no set meales, their store being spent, they champe on the bit, till they meete with fresh supplies, either from their own endeavours, or their wives industry, who trudge to the Clambankes when all other means faile . . ."

Nevertheless, naiads as well as certain aquatic gastropods were utilized extensively and, in the southern latitudes, comprised an almost limitless food resource that was available throughout most if not all seasons. Barnes (1823), commenting on the appearance of unionids, remarked that "Not only is the appearance of the shells different to the eye of the naturalist, but also the taste of the included animals, to the palate of the epicure." Hildreth (1828), in discussing the naiades in the vicinity of Marietta, Ohio, observed

> "Their beauties were not unknown, or neglected by that ancient race of men who once inhabited the pleasant vales of Ohio; as the valves of some of the most interesting kinds are often found buried in mounds, intermixed with other articles considered as valuable by the builders of those venerable monuments of the dead. They must also have been deemed very valuable as an article of food; as we find vast beds of the calcined shells, in the banks of the river, usually several feet below the present surface, and near them a hearth of stone with ashes and fragments of deer and fish bones promiscuously interspersed. In those seasons of the year, when the waters were low, and game scarce, they no doubt constituted a large portion of their food. Some of the species are very fine eating, and much admired by the lovers of shell fish at the present day, particularly the Unio ellipticus and Alasmodonta complanata, which are very large, and in the month of September abound in fat, to the extent of one or two ounces of clear oil in a single individual."

Matteson (1958, 1960) has shown that it may be possible to reconstruct past aquatic environments from the analysis of mollusks recovered in Indian shell heaps and middens. The known habitat requirements of aquatic species represented in such aborginal deposits serve as an index of the former river conditions from which they were collected. Thus far studies dealing with mollusks from archaeological sites in Tennessee have been few in number (see Warren, 1975; Parmalee *et al.*, 1980, 1982). The identification and analysis of over 100,000 naiad and gastropod (aquatic and terrestrial) shells from the shell mounds of the Pickwick Landing Basin in the Tennessee River Valley by Morrison (1942) was one of the earliest and most detailed studies of aboriginal shell deposits from the Southeast. As additional sites, such as CRBRP, are excavated and their faunal materials studied, it will eventually be possible to more accurately reconstruct past environmental conditions and determinme the role animals, especially the mollusks, played in the subsistence of the Indian.

At least 43 species of freshwater mussels were represented in the shell samples recovered at the CRBRP site. Of these 43, valves of six species (*Actinonaias ligamentina*, *Pleurobema cordatum*, *Fusconaia subrotunda*, *Cyclonaias tuberculata, Cyprogenia stegaria, Dromus dromas*) comprised 65% of all the identified mussel shell. Because of their generally large size, the first four would have provided probably the major portion of the meat derived from mussels. However, there was apparently no effort on the part of the individuals who gathered mussels to select only large adult specimens. Juveniles of several species such as *A. ligamentina* and *C. tuberculata* which are among the largest forms, as adults, occurring in the Tennessee River system, were represented in the samples. In addition, considerable numbers of typically small species, for example those of the *Epioblasma* complex, as well as quantities of gastropods, had also been collected by the site's inhabitants. The larger specimens of naiads are more easily observed, or felt when grubbing by hand, and the CRBRP site sample may conceivably reflect this. In all probability the CRBRP site sample reflects the former relative abundance of species inhabiting the shoals and gravel bars adjacent to the site.

Impoundment of the lower Clinch River, as well as all of the Tennessee River and its major tributaries, has detrimentally affected most of the huge mussel beds once found in these waters and has diminished the numbers of the few surviving species. Of the 43 species or forms represented in the CRBRP site samples, at least five are extinct and four are listed as Endangered Species (Bogan and Parmalee, 1983).

It is of interest to note that no speciments of the Three-horned Warty Back, *Obliquaria reflexa* (Rafinesque, 1820); Butterfly, *Ellipsaria lineolata* (Rafinesque, 1820); and the Pink, *Obovaria retusa* (Lamarck, 1819) were recovered in the CRBRP site samples. Today, the first two species occur locally throughout the Tennessee River system and the third very locally below Pickwick Landing Dam; all three were recorded from the lower Clinch before impoundment. The fact that the Fluted Shell, *Lasmigona costata* (Rafinesque, 1820); Fragile Papershell, *Leptodea fragilis* (Rafinesque, 1820); Pink Heelsplitter, *Potamilus alatus* (Say, 1817); and the Spectacle Case, *Cumberlandia monodonta* (Say, 1829), are missing in the samples also seems unusual since they do occur on or adjacent to shoals and gravel/sand bars in the larger rivers and are still found in the Clinch River above impoundment. If these naiads had inhabited the shoals adjacent to the CRBRP site when it was occupied, they must have been extremely rare.

The inequality of the quantity of shell recovered in the Early Woodland, Middle Woodland, and Mississippian components makes a comparison of species utilization by various groups who periodically occupied this site rather superficial. For example, of the approximately 23,900 mussel valves identified, about 85% were from the Middle Woodland components. Shells of *Fusconaia subrotunda, Cyclonaias tuberculata,* the *Pleurobema* complex, *Actinonaias ligamentina*, *Cyprogenia stegaria*, and *Dromus dromas* occurred with about the same frequency in both the Middle Woodland

and Mississippian samples. Combined, valves of these six species varied from approximately 56% (Mississippian) to 67% (Early and Middle Woodland) of the total number of shells in each component. Keeping the discrepancy of sample size in mind, there appears to have been little if any changes in the species composition of the mussel beds during the periods of occupation of the CRBRP site.

The aboriginal utilization of aquatic gastropods reflects two different areas of exploitation, with some differences in emphasis during the three subsequent occupations of the CRBRP site. *Leptoxis* spp. and *Io fluvialis* were collected in the riffle areas with good current, while *Pleurocera canaliculatum*, *Campeloma* spp. and possibly *Lithasia verrucosa* were obtained from eddy areas or backwater areas with little or no current and a cobble, mud or decaying vegetation substratum. The Early Woodland people apparently emphasized collecting from the shallow standing water close to shore, based on the fact that *P. canaliculatum*, *Campeloma* spp., and the two specimens of *L. verrucosa* represent 77% of the gastropod sample. During Middle Woodland times, the emphasis was on collecting the shallow backwater areas, but there was an apparent shift. Specimens from backwater areas still formed 77% of the sample, but *I. fluvialis* comprised 21% of the sample; this suggests that there may now have been an emphasis on collecting *I. fluvialis*, possibly because of its large size. The Mississippian sample is very similar to the Early Woodland, with 98% of the specimens reflecting quiet water-shore area exploitation with a marked decrease in the utilization of riffle species. These fluctuations in the relative importance of *I. fluvialis* in the samples may also be a reflection of fluctuations of the local population numbers.

The method of preparation of these gastropods is currently unknown. No pattern of breakage or evidence for roasting in fire was observed. Morrison (1942) makes the following statement in reference to *Campeloma* spp., but his comments may be expanded to cover all of the above noted gastropods:

> "These snails were in use for food as soon as the shell deposits began to accumulate, but there is no positive indication as to just how they were cooked, unless possibly they were steamed in a pit beneath the fire. Very few of the shells among thousands of individuals seen were fire marked, so we know they were not roasted over the fire."

Because of this lack of evidence of roasting or cooking in an open fire, and because there was no shell breakage pattern, it is reasonable to assume that gastropods may have been boiled in pots and consumed in the form of a broth.

ACKNOWLEDGEMENTS

We would like to express our appreciation to Dr. Gerald F. Schroedl, Department of Anthropology, University of Tennessee, Knoxville for making the CRBRP site molluscs available for study, permission to use the illustration modified for Fig. 1, and for relative data concerning excavation and recovery of the shell. Drs. David H. Stansbery and Carol B. Stein, Museum of Zoology, The Ohio State University, Columbus were especially helpful with the identification of several problem specimens. Our thanks go to W. Miles Wright, Frank H. McClung Museum, University of Tennessee, Knoxville for the preparation of the figures. Early in this study Dr. George M. Davis, Chairman, Department of Malacology, Academy of Natural Sciences of Philadelphia, graciously made the collections under his care available to us. We acknowledge with gratitude the Tennessee Valley Authority for the opportunity to study the CRBRP site molluscs, under provisions of TVA Contract TV-39483A, and to publish the results of this work. A special note of appreciation is extended to Cynthia M. Bogan for typing the manuscript.

This paper has benefited greatly from careful editing by two external reviewers and to these individuals we express our sincere appreciation.

LITERATURE CITED

Adams, C.C. 1900. Variation in *Io*. *Proceedings, American Association of Science* 49:208-225.

Adams, C.C. 1915. The variations and ecological distribution of the snails of the genus *Io*. *Memoirs, National Academy of Science* 12(pt. II):1-86.

Ahlstedt, S.A. 1984. Twentieth Century changes in the freshwater mussel fauna of the Clinch River (Tennessee and Virginia). MS. Thesis, Department of Wildlife and Fisheries, University of Tennessee, Knoxville. 102 pp.

Baker, F.C. 1902. The mollusca of the Chicago Area, Part II. Gastropoda. *Chicago Academy of Science, Natural History Survey Bulletin* No. 3, pp. 131-410, pls. 28-36.

Barnes, D.H. 1823. On the genera Unio and Alasmodonta; with introductory remarks. *The American Journal of Science and Arts* 6:107-127.

Bates, J.M. and S.D. Dennis. 1978. The mussel fauna of the Clinch River, Tennessee and Virginia. *Sterkiana* No. 69-70, pp. 3-23.

Bennett. M.K. 1955. The food economy of the New England Indians, 1605-75. *Journal of Political Economy* 63(5):369-397.

Bickel, D. 1968. Checklist of the mollusca of Tennessee. *Sterkiana* No. 31, pp. 15-39.

Binney, W.G. 1865. Land and fresh-water shells of North America Part II. *Smithsonian Miscellaneous Collections* 7(144, pt. 3): 1-122 + VIII.

Bogan, A.E. and P.W. Parmalee. 1983. Tennessee's Rare Wildlife. Volume II: The Mollusks. Tennessee Wildlife Resources Agency, Nashville, Tennessee, 123 pp., 53 maps, 53 plates.

Burch, J.B. 1975. *Freshwater Unionacean Clams (Mollusca: Pelecypoda) of North America*. Malacological Publications, Hamburg, Michigan. 204 pp.

Burch, J.B. 1982. Freshwater snails (Mollusca: Gastropoda) of North America. U.S. Environmental Protection Agency, Research and Development, Vol. EPA-600/3-82-026, 294 pp. Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Cahn, A.R. 1936. The molluscan fauna of the Clinch River below Norris Dam upon completion of that structure. Unpublished TVA Report. 18 pp. Norris, Tennessee.

Clench, W.J. 1962. A catalogue of the Viviparidae of North America with notes on the distribution of *Viviparus georginanus* Lea. *Occasional Papers on Mollusks* 2(27). The Department of Mollusks, Museum of Comparative Zoology, Harvard University, Cambridge.

Cole, P.E. 1975. A synthesis and interpretation of the Hamilton Mortuary Pattern in East Tennessee. MA. Thesis, Department of Anthropology, University of Tennessee, Knoxville. 94 pp.

Goodrich, C. 1937. Studies of the gastropod family Pleuroceridae—VI. *Occasional Papers, Museum of Zoology, University of*

Michigan 347:1-12.

Goodrich, C. 1938. Studies of the gastropod family Pleuroceridae - VII. *Occasional Papers, Museum of Zoology, University of Michigan* 376:1-12.

Greenwalt, L.A. 1976. Endangered and threatened wildlife and plants, *Federal Register* 41(115):24062-24067.

Hickman, M.E. 1937. A contribution to Mollusca of east Tennessee. Unpublished MS. thesis, Department of Zoology, University of Tennessee, Knoxville, 165 pp. 104 pl.

Hildreth, S.P. 1828. Observations on, and descriptions of the shells, found in the waters of the Muskingum River, Little Muskingum and Duck Creek, in the vicinity of Marietta, Ohio. *The American Journal of Science and Arts* 14:276-291.

Isom, B.G., S.D. Dennis, and C. Gooch. 1979. Rediscovery of some Pleurocerids (Gastropoda) near Muscle Shoals, Tennessee River, Alabama. *The Nautilus* 93(2-3):69-70.

Johnson, R.I. 1978. Systematics and zoogeography of *Plagiola (=Dysnomia=Epioblasma)*, an almost extinct genus of freshwater mussels (Bivalvia: Unionidae) from middle North America. *Bulletin of the Museum of Comparative Zoology* 148(6):239-321.

Kingman, D.C. 1900. Final report on survey of Clinch River, Tennessee. *House Executive Document No. 75*, 56th Congress, 2nd Session 60:1-56, No. 4134.

Lewis, J. 1876. *Io* and its habits. *American Naturalist* 10:321-335.

Lewis, T.M.N. and M. Kneberg. 1957. The Camp Creek Site. *Tennessee Archaeologist* 13(1):1-48.

Lutz, L. and A.O. Weese. 1951. Variation in *Io*, fifty years later. *Proceedings of the Oklahoma Academy of Science* 32:11-13.

Matteson, M.R. 1958. Analysis of an environment as suggested by shells of freshwater mussels discarded by Indians of Illinois. *Transactions of the Illinois State Academy of Science* 51(3&4):8-13.

Matteson, M.R. 1960. Reconstruction of prehistoric environments through the analysis of molluscan collections from shell middens. *American Antiquity* 26(1):117-120.

Morris, P.A. 1939. *What Shell is That?* D. Appleton-Century Company, New York, 198 pp.

Morrison, J.P.E. 1942. Preliminary report on mollusks found in the shell mounds of the Pickwick Landing Basin in the Tennessee River Valley. In: Archaeological Survey of Pickwick Basin in the Adjacent Portions of the States of Alabama, Mississippi and Tennessee, William S. Webb and David L. DeJarenett. *Bureau of American Ethnology, Bulletin* 129, pp. 337-392. Washington.

Nash, C.H. n.d. Unpublished site survey records, Watts Bar Reservoir Survey, 1941. On file at University of Tennessee, McClung Museum, Knoxville.

Neel, J.K. and W.R. Allen. 1964. The mussel fauna of the upper Cumberland Basin before its impoundment. *Malacologia* 1(3):427-459.

Ortmann, A.E. 1918. The nayades (freshwater mussels) of the Upper Tennessee Drainage, with notes on synonymy and distribution. *Proceedings, American Philosophical Society* 57:521-626.

Ortmann, A.E. 1920. Correlation of the shape and station in freshwater mussels. *Proceedings of the American Philosophical Society,* 19:269-312.

Ortmann, A.E. 1925. The naiad-fauna of the Tennessee River system below Walden Gorge. *American Midland Naturalist* 9(8):321-372.

Parmalee, P.W. and W.E. Klippel. 1974. Freshwater mussels as a prehistoric food resource. *American Antiquity* 39(2)421-434.

Parmalee, P.W., W.E. Klippel and A.E. Bogan. 1980. Notes on the prehistoric and present status of the naiad fauna of the middle Cumberland River, Smith County, Tennessee. *The Nautilus* 94(3):93-105.

Parmalee, P.W., W.E. Klippel and A.E. Bogan. 1982. Aboriginal and freshwater mussel assemblages (Pelecypoda: Unionidae) from the Chickamauga Reservoir, Tennessee. *Brimleyana* No. 8:75-90.

Pilsbry, H.A. and S.N. Rhoads. 1897. Contributions to the zoology of Tennessee No. 4, mollusks. *Proceedings of the Academy of Natural Sciences of Philadelphia for 1896* 48:487-506.

Schroedl, G.F. 1973a. Salvage Archaeology in the Clinch River Breeder Reactor Plant Area, Progress report for October 1973. Report submitted to the Tennessee Valley Authority and the Project Management Corporation, Knoxville. 3 pp.

Schroedl, G.F. 1973b. Salvage Archaeology in the Clinch River Breeder Reactor Plant Area, progress report for November, 1973. Report submitted to the Tennessee Valley Authority and the Project Management Corporation, Knoxville. 3 pp.

Schroedl, G.F. 1973c. Salvage Archaeology in the Clinch River Breeder Reactor Plant Area, progress report for December, 1973. Report submitted to the Tennessee Valley Authority and the Project Management Corporation, Knoxville. 7 pp.

Schroedl, G.F. 1974. Salvage Archaeology in the Clinch River Breeder Reactor Plant Area, progress report for January and February 1974. Report submitted to the Tennessee Valley Authority and the Project Management Corporation, Knoxville. 12 pp.

Schroedl, G.F. 1975. Archaeological Investigations in the Clinch River Breeder Reactor Plant Area, progress report for December 1974. Report submitted to the Tennessee Valley Authority and the Project Management Corporation, Knoxville. 11 pp.

Sinclair, R.M. 1969. The Pleurocerid fauna of the Tennessee River Gastropoda: Prosobranchia. *The American Malacological Union, Inc., Annual Reports for 1969* pp. 45-47.

Smith, D.C. and F.M. Hodges, Jr. 1968. The Rankin Site, Cocke County, Tennessee. *Tennessee Archaeologist* 24(2):37-91.

Stansbery, D.H. 1970. Eastern freshwater mollusks (I) The Mississippi and St. Lawrence River Systems. *Malacologia* 10(1):9-22.

Stansbery, D.H. 1971. Rare and endangererd freshwater mollusks in Eastern United States: In: *Rare and Endangered Mollusks (Naiads) of the U.S.* S.E. Jorgensen and R.W. Sharp (ed.) pp. 5-18. Bureau of Sport Fisheries and Wildlife, United States Department of the Interior, Twin Cities, Minnesota.

Stansbery, D.H. 1973. A preliminary report on the naiad fauna of the Clinch River in the Southern Appalachian Mountains of Virginia and Tennessee (Mollusca:Bivalvia:Unionidae). *American Malacological Union, Inc., Annual Reports for 1973* pp. 45-47.

Stein, C.B. 1976. Gastropods. In: Endangered and Threatened Plants and Animals of Alabama. Herbert Boschung, ed., *Bulletin Alabama Museum of Natural History, No. 2* pp. 21-41.

Walker, B. 1908. On certain immature Anculosae. *Nautilus* 21(10): 110-117.

Warren, R.E. 1975. Prehistoric Unionacean (Freshwater Mussel) utilization at the Widows Creek Site (1JA305), Northeast Alabama. Unpublished MA. Thesis, Department of Anthropology, University of Nebraska, Lincoln. 245 pp.